RESEARCH REPORT

ANIMAL WELFARE

Title: Establishing bedding requirements for finisher pigs during transportation and skin surface temperature during different seasons after transportation -**NPB#10-176** **revised**

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Date Submitted: 4-30-2012

Industry Summary:

Producers and packers would like to reduce dead and down market pigs during transportation for economic and welfare reasons. Transport losses may be due to pig genetics, management before, during and after transportation, handling and environmental factors to identify a few. Environmental factors during transportation can be partly controlled whereas some of the components of environment cannot be controlled by human effort. Temperature, humidity, ventilation and air speed in close contact with pigs, termed as the micro environment, play a crucial role that can impact pork quality and transport losses.. There are few peer reviewed studies conducted in this area focusing on the microenvironment inside the trailer. Because transported pigs are in close contact with bedding, the type, quality and level of bedding may be important factors associated with the rate of dead and down market pigs.

The objective of this study was to establish the level of bedding to be used while transporting market pigs from finishing sites to packing plants in the U.S. over different seasons and weather conditions. This work is a challenge due to the large sample size needed and the need for study personnel at both the farm and plant during data collection.

The study was divided into three parts; winter (January and February), mild (March and May) and warm summer months (June and July) in the mid-west region of U.S. (Iowa, Minnesota and Missouri). Three levels of bedding; low (3 bales), medium (6 bales) and high (12 bales) were assigned randomly to the trailers within each season. Only medium and heavy levels of bedding were used during winter; low, medium and heavy during mild and only low and medium bedding levels were evaluated during the summer period.

This study was conducted in field while market pigs were transported from finishing sites to the packing plants. Variables measured at the finishing site include bedding information, trailer information, handling method, devices and intensity, information on farm design and management, and external environmental condition. Sensors set to record relative humidity (RH) and temperatures every 5-minute during loading, transit, waiting at the farm and unloading were installed in selected trailers in four compartments; top front, top rear, bottom front and bottom rear. Surface skin temperatures on the pig's flank/side of 10 randomly selected pigs (5 of first 50 and 5 of last 50 pigs loaded into the trailer) in each load were also taken with an infrared laser thermometer (Extech model # 42570) with a sensitivity of 0.1 °F. At the packing plants, weather information, handling methods, intensity and devices, dead on arrival, non-ambulatory and total dead and down information were collected.

Major findings and recommendations of the study based on the total loss of the pigs include:

1. During cold weather (<32 °F), there was no significant bedding effect, so there is no advantage of added bedding beyond 6 bales/trailer;

2. Similarly, during mild weather (32-70 °F), there was no significant bedding effect, so there was no advantage of added bedding beyond 3 bales/trailer;

3. But during warm weather (<70 °F), added bedding had a negative effect on dead on arrival beyond 3 bales/trailer;

4. Pig surface temperature increased with air temperature and during warm weather increased surface temperature predicts increased DOA.

Suggested recommendations in bedding level use:

1. During cold weather, a maximum of 6 bales of bedding per trailer is recommended and during mild weather 3 bales per trailer is recommended. During warm weather no more than 3 bales of bedding per trailer is recommended.

2. Surface temperature can be used as non-invasive method to assess pig welfare and predict dead on arrival of pigs during warm weather.

Further research is required to determine if lower amount of bedding is required during winter (less than 6 bales) and warm weather (less than 3 bales or no bedding). Also, boarding and misting requirements need to be determined to improve internal trailer environment and welfare of pigs during transportation.

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ABSTRACT

Potential benefits of using different levels of bedding in trailers while transporting market pigs from finishing sites to the slaughter plants in different seasons were investigated. The objective of the study was to define the bedding requirements of pigs during transportation in commercial settings during cold, mild and warm weathers. Animals used were raised in commercial finishing sites as per industry standard practices. Three bedding levels low, medium and high (3 bales, 6 bales and 12 bales respectively) were assigned randomly to the trailers in which finishing pigs were transported and dead on arrival (DOA), non-ambulatory (NA) and total dead and down were used as a measure of bedding level efficacy and pig welfare. Skin surface temperatures of the pigs were analyzed as a non-invasive method to measure welfare. The research was divided into three experiments overthree different seasons; winter, mild and summer. Temperature ranges was divided into bins of 5 °C. In experiment 1, in January and February, bedding levels used were heavy (12 bales) and medium (6 bales). Total dead and down percentage when medium level of bedding was used was 0.11% whereas when high level of bedding was used, total dead and down percentage was 0.18% ($P = 0.29$). In experiment 2, in March and May, three levels of bedding heavy (12 bales), medium (6 bales) and light (3 bales) were used. Total dead and down percentages were 0.20, 0.21 and 0.09% in low, medium and heavy bedding level respectively ($P = 0.34$). In experiment 3, in June and July, bedding level was classified into four different levels 3, 5, 7 and 9 bags of bedding. Total dead and down percentages were 0.17, 0.42, 0.46 and 0.53% respectively in 3, 5, 7 and 9 bags of bedding ($P = 0.08$). Total dead and down percentage showed no interaction between bedding level and outside air temperature in all three experiments. Average skin surface temperature during unloading increased with outside air temperature linearly in all three experiments ($P < 0.01$).

Key words: bedding level, microenvironment, pigs, surface skin temperature

INTRODUCTION

Pigs are handled frequently, mixed socially into new groups, and moved to different accommodations and facilities from birth to slaughter (Stephens and Perry, 1990) as the pig industry has grown into a largely multi-

site production industry. Losses of pigs induced by different stressors can be reduced by proper facility design, modification of existing facilities, handling methods and clear understanding of behavior and physiology of pigs. Much care has been given to the genetics of pigs raised, management practices at the farm and handling of the animals at the finishing site and plant and less care has been given to the micro environment control in the trailer when pigs are being transported. Scientific studies have begun in the area of improvement of facility and trailer design with respect to ventilation (overall and in each compartment), mister, drainage, feeder, drinker, drainage and level of bedding considering the external environment while transporting. Microclimate environment plays a major role in the well-being of pigs being transported. Sutherland et al. (2009) have identified the factors that influence in losses in transit include the micro-environment (air temperature, relative humidity), loading density, transit time and also wait time after the pigs are loaded into trailer, stop time in transit and also wait time at the plant. Temperature, humidity, air speed, air pressure, level of gas and the amount and condition of any bedding have been identified as major micro environment component (Ellis et al., 2008). Based on computer simulated models, Ellis et al. (2008) have also suggested proper trailer ventilation (openings; boards or plugs) depending on the compartment and better control of internal environment. Level of bedding material can also be a crucial component in controlling the micro environment that pigs face during transportation.

The National Pork Board introduced a training program for truckers called as Trucker Quality Assurance (TQA) program. The TQA program has recommendations for truck set-up regarding the level of bedding to be used and percentage of side slats to be closed or opened at different temperature ranges. TQA Handbook (2008) suggests use of heavy bedding (4 bags/deck) and 10% side-slats open at less than -12 °C, medium bedding (3 bags/deck) and 25% side-slats open at -12 to -7 °C, medium bedding (3 bags/deck) and 50 percent side-slats open at -6.6 to 3.8 °C, light bedding (2 bags/deck) and 75% side-slats open at 4.44 to 9.44 °C and light bedding (2 bags/deck) and 100% side-slats open at more than 10 °C.

MATERIALS AND METHODS

General

A total of over 131,240 finisher pigs (mixed genetics) going to commercial slaughter houses were observed when they are loaded and unloaded. Each trailer transported approximately 160-180 pigs at a time. Finishing pigs were from commercial farms in Iowa and Minnesota and were processed either in Missouri or Iowa. The two plants that cooperated wish to remain anonymous. All pigs were market weight pigs of both sexes (barrows and gilts). The experimental protocol for this study was approved by Institutional Animal Care and Use Committees at Texas Tech University and Iowa State University.

At finishing sites

Bedding levels were randomly assigned to trailers. The transport companies applied the bedding. Information about the level of bedding used inside the trailers, number of loads on that bedding and boarding percentage of the trailer were collected at the finishing site and confirmed at the plant. Time required to load the pigs was recorded. Sensors to collect information on temperature and humidity during loading, transit, waiting at the farm and unloading were installed in selected trailers in four compartments; top front, top rear, bottom front and bottom rear. Sensors (Extech model RHT10) were set to record relative humidity (RH) and temperatures every 5 minutes. Handling device(s) used and handling intensity (measured in a scale of 1 to 5, 1 being the mildest) during loading were also recorded. Number of vocalizations, slips/falls and signs of stress (ex., open-mouth breathing, red skin; Gesing et al., 2010) were recorded. Information regarding management aspects of the pig farming such as type of barn, facilities like pen size, aisle, chute, floor type, walls etc., and weather information (temperature, humidity, and wind speed) were collected. Surface skin temperatures on the pig's flank/side of 10 randomly selected pigs (5 of first 50 and 5 of last 50 pigs moved onto or off the trailer) in each load were also taken with an infrared laser thermometer (Extech model # 42570) with a sensitivity of 0.1 °C.

At plant

Information regarding weather, air temperature, humidity, surface temperature of 10 pigs (as in finishing site), handling device(s), handling intensity (as in finishing site), vocalizations, slips/falls, time of arrival, waiting and unloading were collected at the plant. Samples of bedding after transporting pigs were collected throughout the trailer to analyze for moisture percentage. Two 75 mL scoops of bedding were collected, one from the center of the bottom deck and one from the center of the top deck. Bedding samples were placed in a Ziploc bag and frozen until they were weighed in wet and dried state (after overnight in a drying oven). Total numbers of dead on arrival, non-ambulatory and dead and down pigs in each trip were also recorded.

Experiment 1; Winter

Data were collected in January and February, 2011 and bedding levels assigned randomly to the trailers. Only high (12 bales) and medium (6 bales) levels of bedding were used during these months. Outside air temperature at plant varied from -13 °C to 20 °C. A total of 28,855 pigs were observed for which data on at least bedding level, dead on arrival and non-ambulatory were collected.

Experiment 2; Mild

Data were collected in March and May, 2011and bedding levels assigned randomly to the trailers. Heavy (12 bales), medium (6 bales) and light (3 bales) levels of bedding were used during these months and outside air temperature at the plant varied from -2 °C to 21 °C. Data were collected on a total of 58,000 pigs for which at least data on bedding level, dead on arrival and non-ambulatory were collected.

Experiment 3; Summer

Data were collected in June and July and bedding levels ranged from 2 bales to 9 bales/trailer. So the bedding levels were categorized as 3 (2 and 3 bales), 5 (4 and 5 bales), 7 (6 and 7 bales) and 9 (8 and 9 bales/trailer). Outside air temperature in plant ranged from 16 °C to 45 °C. Data were collected on a total of 43,180 pigs for which at least data on bedding level, dead on arrival and non-ambulatory were collected.

Statistical Analysis

Primary models included the effects of level of bedding, outside air temperature and interaction of level of bedding and outside air temperature. Outside air temperature was divided into the bins of 5 °C for analysis. All data was entered in Excel and analyzed using SAS 9.2 (General Linear Model). Regression lines were calculated using Excel and SAS.

RESULTS

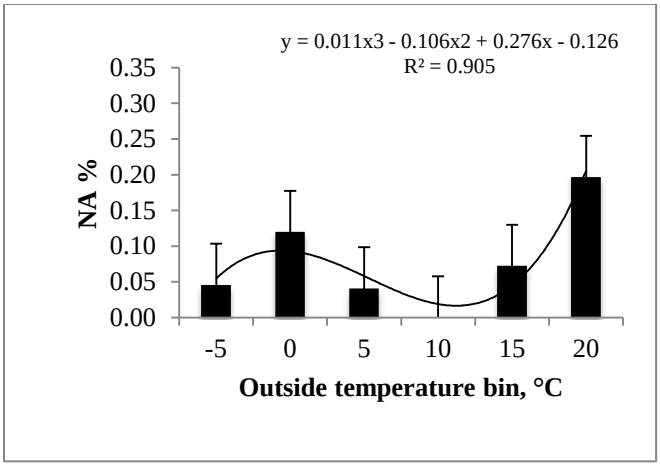
Experiment 1 -- winter. There was no ($P > 0.05$) main effect of bedding for dead on arrival (DOA), non-ambulatory (NA) and total dead and down (D&D). The effects of bedding level on DOA, NA and D&D for cold weather are summarized in Table 1.

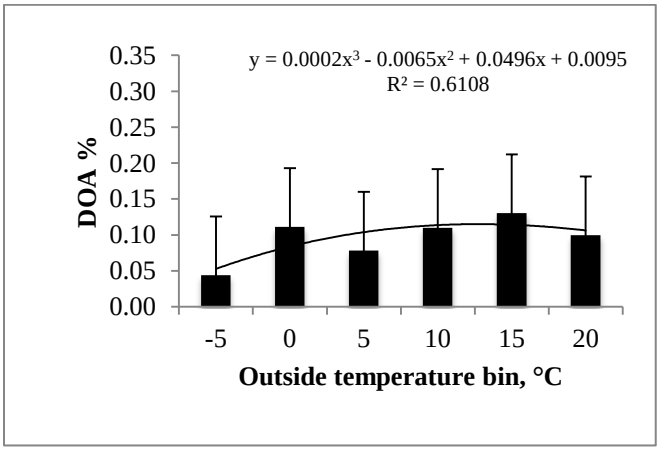
Table 1. Effect of bedding level on dead on arrival (DOA), non-ambulatory (NA) and total dead and down (D&D) during winter.

	Bedding level		**SE**	**P-value**
Measure	6	12		
DOA%	0.06	0.12	0.03	0.13
NA%	0.05	0.07	0.03	0.73
D&D%	0.11	0.18	0.04	0.29

SE: standard error

DOA %, NA % and D&D % were not affected by bedding and air temperature. Figure 1 shows the percentage of DOA, NA and D & D pigs depending upon the outside air temperature bins in cold weather.





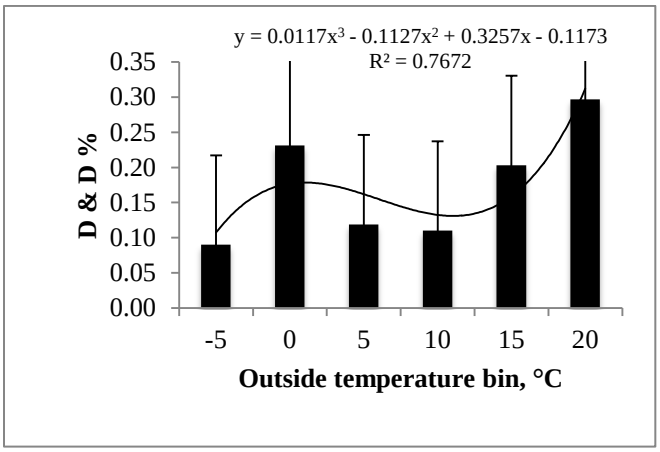


Figure 1. Least square means of DOA, NA and D & D % respectively in relation to outside temperature bins in cold weather

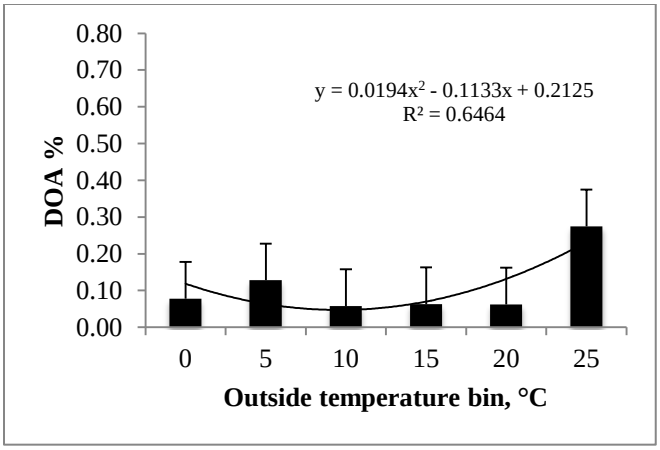
Experiment 2 – mild weather. There was no (P > 0.05) main effect of bedding on dead on arrival (DOA), non-ambulatory (NA) and total dead and down (D&D). The effects of three bedding levels on DOA, NA and D&D for mild weather are summarized in Table 2.

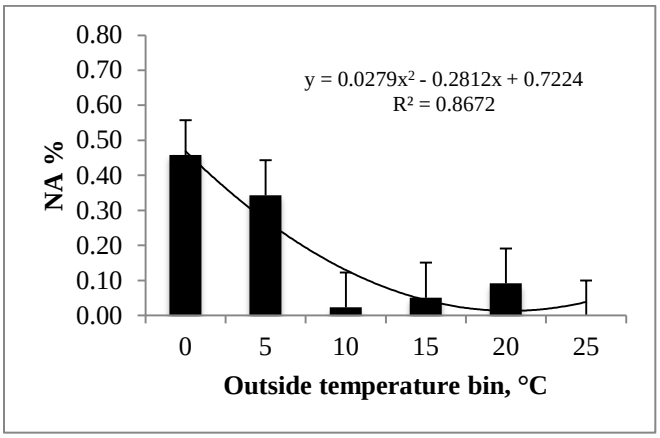
Table 2. Effect of bedding level on dead on arrival (DOA), non-ambulatory (NA) and total dead and down (D&D) during mild weather.

	Bedding level			**SE**	**P-value**
Measure	3	6	12		
DOA%	0.11	0.12	0.03	0.03	0.21
NA%	0.09	0.10	0.13	0.03	0.84
D&D%	0.20	0.22	0.09	0.05	0.34

SE: standard error

DOA %, NA % and D&D % were not affected by bedding and air temperature. Figure 2 shows the percentage of DOA, NA and D & D pigs depending upon the outside air temperature bins in mild weather.





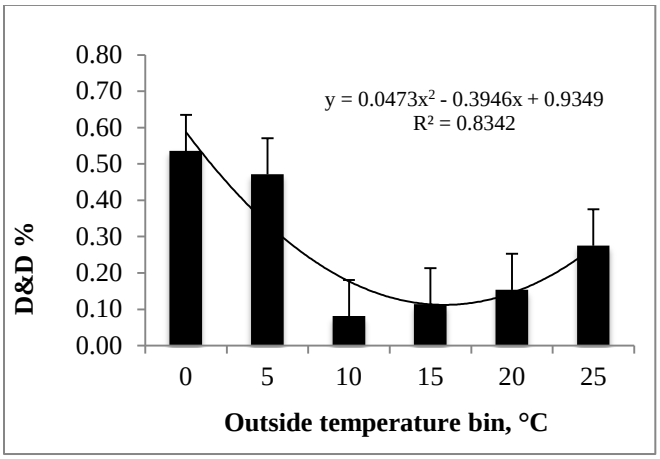


Figure 2. Least square means of percentage of DOA, NA and D & D respectively in relation to outside temperature bins in mild weather

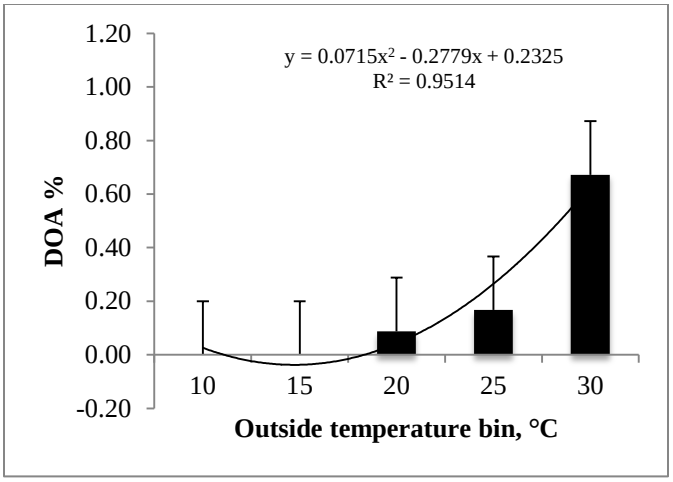
Experiment 3. There was a significant ($P > 0.05$) main effect of bedding on dead on arrival (DOA), and total dead and down (D&D) in the summer. More bedding was harmful in warm weather. The effects of different bedding levels on DOA, NA and D&D for mild weather are summarized in Table 3.

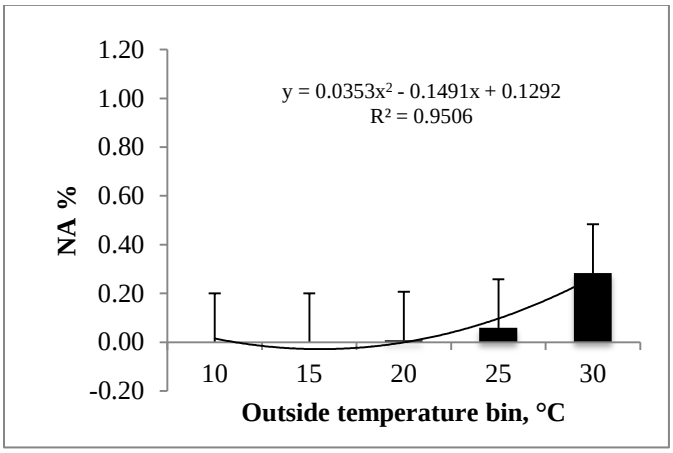
Table 3. Effect of bedding level on dead on arrival (DOA), non-ambulatory (NA) and total dead and down (D&D) during summer.

	Bedding level				**SE**	**P-value**
Measure	3	5	7	9		
DOA%	0.13	0.27	0.35	0.42	0.08	0.05
NA%	0.04	0.20	0.13	0.11	0.06	0.20
D&D%	0.17	0.42	0.47	0.53	0.12	0.07

SE: standard error

DOA %, NA % and D&D % were not affected by bedding and air temperature. Figure 3 shows the percentage of DOA, NA and D & D pigs depending upon the outside air temperature bins in warm weather.





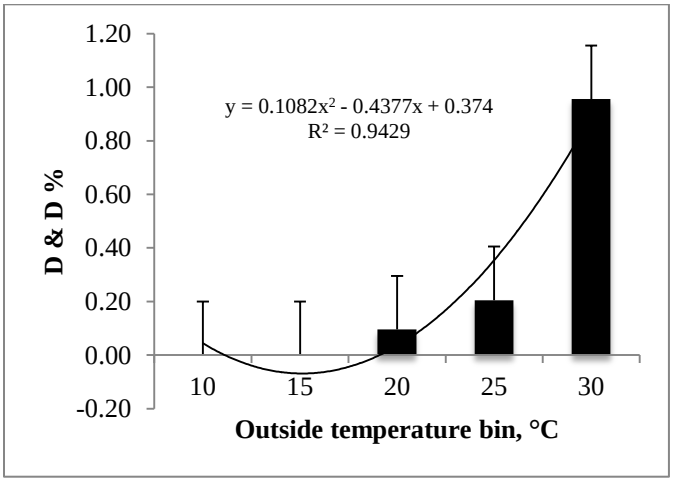


Figure 3. Least square means of percentage of DOA, NA and D & D respectively in relation to outside temperature bins in warm weather.

The effect of bedding and outside air temperature were additive in warm weather. DOA % was 1.1% when 9 bags of bedding were used and the outside air temperature was above 30 °C as shown in Figure 4.

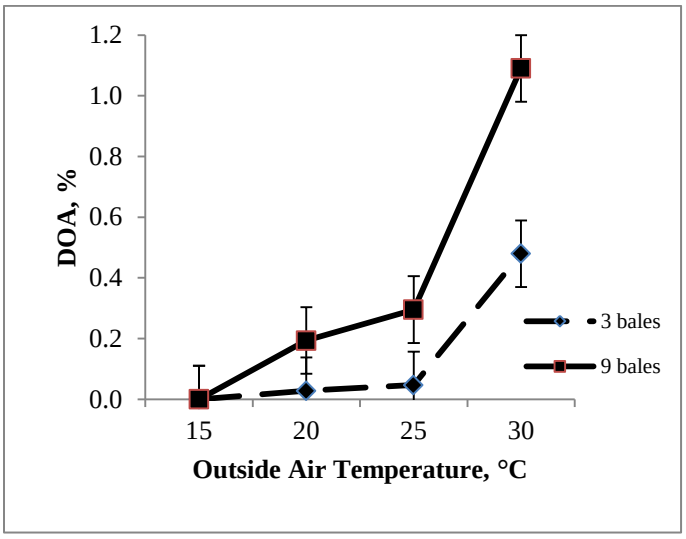


Figure 4. Combined temperature and bedding effects on least square means percentage of DOA during warm weather

Surface skin temperature: When surface skin temperature was plotted against outside air temperature, surface skin temperature of the pigs coming out of the trailer at the slaughter plant increased linearly with increasing outside air temperature as shown in the Figure 5.

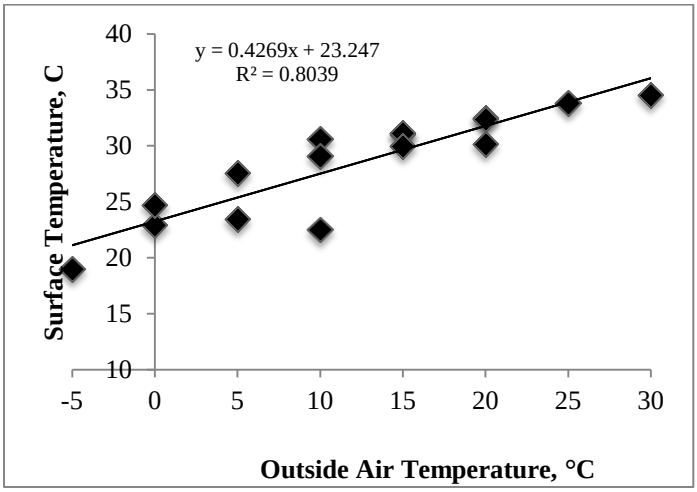


Figure 5. Surface skin temperature of pigs when unloaded at the slaughter plant as compared to outside air temperature.

Also, during warm weather, when surface temperature of the pigs was plotted against total dead and down percentage, surface temperature was indicative of dead and down as shown in Figure 6 indicating that total dead and down percentage was higher as surface skin temperature went high.

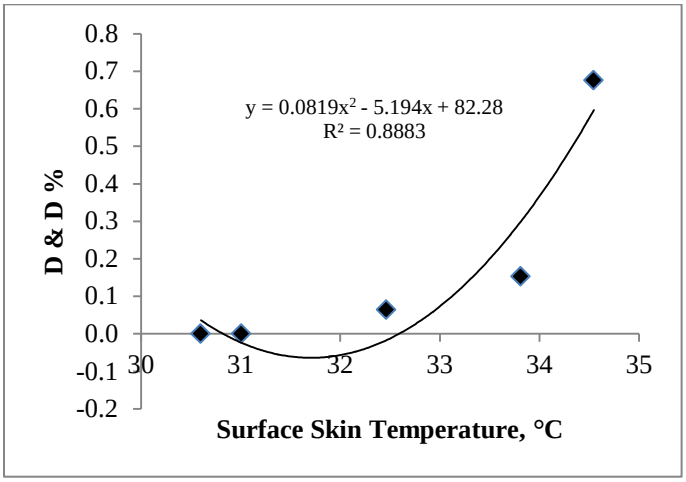


Figure 6. Relationship between surface skin temperature and least square means percentage of dead and down during warm weather

DISCUSSION

Ethical transport of finishing pigs from farm to the slaughter house is an important aspect of pig production. Transportation is equally important economically as in-transit loss of pigs was estimated to be approximately $46 million in 2006 (Ritter et al., 2009).

Different types of mortality and losses that occur during transportation have been defined by researchers. Ritter et al. (2009) defined transport losses as any mortality or non-ambulatory pigs during transportation from grower-finisher site to the slaughter house. Definitions of the related terms are summarized as below:

- Dead on arrival (DOA): Those pigs which die during transit.

- Dead in pen: Those pigs which die after having been unloaded.
- Non-ambulatory (NA): Those pigs which are unable to move or keep up with other unloaded pigs and have to be tilled in the suspect of disease. These non-ambulatory pigs are also referred as suspect, subjects, cripples, slows, stressors etc. Non-ambulatory pigs can be of two categories.
    - Fatigued pigs or non-ambulatory non-injured (NANI): Those pigs which do not have any obvious signs of injury, trauma or disease.
    - Injured pigs or non-ambulatory injured (NAI): Those pigs which cannot move or walk due to the injury during any stage of transportation and show clear sign of injury, trauma or diseased condition.

Transportation can be a stressor to the pigs and this has been shown by measuring metabolic products and hormones such as cortisol. In addition, transit losses causing a reduction in carcass yield, and increases in DOA, NAI and NANI pigs (Warris et al, 1983; Becker et al., 1985; Bradshaw et al., 1996; Minka and Ayo, 2010). Factors like stocking density, distance and time of transportation, feed withdrawal, handling before, during and after transportation, season, type of trailer, internal microenvironment such as temperature, humidity, and ventilation have been identified as factors associated with in transit losses (Lambooy and Engel, 1991; Lewis et al, 2005; Haley et al., 2008; Johnson et al., 2010; Lewis et al., 2010). Fitzgerald et al. (2009) identified that total losses percentage per trailer were higher during winter as compared to other weather and losses during winter were mainly due to fatigued pigs whereas losses during summer were mainly due to dead pigs. These papers correlated in-transit losses with stocking density, season, trailer design, ventilation etc but none of the researches conducted correlated in-transit losses to the level of bedding used.

Result obtained from this study showed that use of higher level of bedding did not improve the in-transit losses measured as DOA, NA and D & D, during winter as opposed to the recommended level of bedding by The National Pork Board in th eTQA Handbook, 2008. Similarly, no benefit was observed using higher level of bedding during mild and warm weather. In fact use of higher level of bedding (9 bales) during warm weather resulted in higher DOA % as compared to when lower level of bedding (3 bales) was used as shown in Figure 4.

Surface skin temperature of the pigs during unloading increased linearly with the outside temperature. Also, during summer, surface skin temperature can be used as an important indicator of total dead and down (Figure 6). This means pig surface skin temperature can be used as a non-invasive method to assess the welfare of pigs being transported during summer.

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